Hellbender Education

LESSON PLAN 1: GENERAL ECOLOGICAL CONCEPTS

MIDDLE SCHOOL STANDARDS ADDRESSED (BY STATE):

NGSS (Kentucky, Maryland)	**MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.** ***Clarification Statement:*** Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources. ***Disciplinary Core Ideas:*** ● Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. ● In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. ● Growth of organisms and population increases are limited by access to resources.
Pennsylvania	**4.1.7.A.: Describe the relationships between biotic and abiotic components of an ecosystem.** ● Compare and contrast different biomes and their characteristics. ● Describe symbiotic and predator/ prey relationships. **4.1.7.C.: Explain the flow of energy within an ecosystem.** ● Compare and contrast the flow of energy between organisms in different habitats. ● Explain the concept of trophic levels.
West Virginia	**S.6.LS.1: Students will construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.** **S.6.LS.6: Students will develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.**
Virginia	**LS.6: The student will investigate and understand that organisms within an ecosystem are dependent on one another and on non-living components of the environment.** Key concepts include a) the carbon, water, and nitrogen cycles; b) interactions resulting in a flow of energy and matter throughout the system; c) complex relationships within terrestrial, freshwater, and marine ecosystems; and d) energy flow in food webs and energy pyramids. **LS.7: The student will investigate and understand that interactions exist among members of a population.** Key concepts include

	a) competition, cooperation, social hierarchy, territorial imperative; and b) influence of behavior on a population. **LS.8: The student will investigate and understand interactions among populations in a biological community.** Key concepts include a) the relationships among producers, consumers, and decomposers in food webs; b) the relationship between predators and prey; c) competition and cooperation; d) symbiotic relationships; and e) niches.
North Carolina	**6.L.2: Understand the flow of energy through ecosystems and the responses of populations to the biotic and abiotic factors in their environment.** ● 6.L.2.1: Summarize how energy derived from the sun is used by plants to produce sugars (photosynthesis) and is transferred within food chains and food webs (terrestrial and aquatic) from producers to consumers to decomposers. **8.L.3: Understand how organisms interact with and respond to the biotic and abiotic components of their environment.** ● 8.L.3.1: Explain how factors such as food, water, shelter and space affect populations in an ecosystem. ● 8.L.3.3: Explain how the flow of energy within food webs is interconnected with the cycling of matter (including water, nitrogen, carbon dioxide and oxygen).
Tennessee	**6.LS2: Ecosystems: Interactions, Energy, and Dynamics** 1. Evaluate and communicate the impact of environmental variables on population size. 2. Determine the impact of competitive, symbiotic, and predatory interactions in an ecosystem. 3. Draw conclusions about the transfer of energy through a food web and energy pyramid in an ecosystem. 6. Research the ways in which an ecosystem has changed over time in response to changes in physical conditions, population balances, human interactions, and natural catastrophes. 7. Compare and contrast auditory and visual methods of communication among organisms in relation to survival strategies of a population. **7.LS2: Ecosystems: Interactions, Energy, and Dynamics** 1. Develop a model to depict the cycling of matter, including carbon and oxygen, including the flow of energy among biotic and abiotic parts of an ecosystem.

HIGH SCHOOL STANDARDS ADDRESSED (BY STATE):

NGSS (Kentucky, Maryland)	**HS-LS2-6: Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent**

	numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. ***Clarification Statement:*** Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise. ***Disciplinary Core Ideas:*** ● A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.
Pennsylvania	**4.1.10.A.: Examine the effects of limiting factors on population dynamics.** ● Analyze possible causes of population fluctuations. ● Explain the concept of carrying capacity in an ecosystem. ● Describe how organisms become classified as threatened or endangered. ● Describe how limiting factors cause organisms to become extinct. **4.1.10.C. Evaluate the efficiency of energy flow within a food web.** ● Describe how energy is converted from one form to another as it moves through a food web (photosynthetic, geothermal). **4.2.10.A.: Examine the interactions between abiotic and biotic factors within a watershed.** ● Investigate and analyze the effects of land use on the quality of water in a watershed.
West Virginia	**S.10.LS.8: Students will use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** **S.10.LS.10: Students will use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.** **S.10.LS.11: Students will use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.**
Virginia	**BIO.8: The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems.** Key concepts include a) interactions within and among populations including carrying capacities, limiting factors, and growth curves; b) nutrient cycling with energy flow through ecosystems;

	c) succession patterns in ecosystems; d) the effects of natural events and human activities on ecosystems; and e) analysis of the flora, fauna, and microorganisms of Virginia ecosystems.
North Carolina	**Bio.2.1: Analyze the interdependence of living organisms within their environments.** ● Bio.2.1.2: Analyze the survival and reproductive success of organisms in terms of behavioral, structural, and reproductive adaptations. ● Bio2.1.3: Explain various ways organisms interact with each other (including predation, competition, parasitism, mutualism) and with their environments resulting in stability within ecosystems. ● Bio2.1.4: Explain why ecosystems can be relatively stable over hundreds or thousands of years, even though populations may fluctuate (emphasizing availability of food, availability of shelter, number of predators and disease).
Tennessee	**BIO1.LS2: Ecosystems: Interactions, Energy, and Dynamics** 1. Analyze mathematical and/or computational representations of population data that support explanations of factors that affect population size and carrying capacities of populations within an ecosystem. Examine a representative ecosystem and, based on interdependent relationships present, predict population size effects due to a given disturbance. 4. Analyze data demonstrating the decrease in biomass observed in each successive trophic level. Construct an explanation considering the laws of conservation of energy and matter and represent this phenomenon in a mathematical model to describe the transfer of energy and matter between trophic levels.

STUDENT OBJECTIVE: Students will apply a variety of general ecological concepts to construct new knowledge about the hellbender salamander, its habitat, and the biotic and abiotic factors with which it interacts. These concepts include:

a) Ecological niche
b) Food webs
c) Energy transfer
d) Predator/prey dynamics
e) Resource competition
f) Life history

LESSON OVERVIEW:

Time	Instructional Sequence	Activity Summary
15 min	Engage	*The Last Dragons:* A quick video introduction to the hellbender salamander, produced by *Freshwaters Illustrated.*
	Explore	Hellbender life cycle: students construct a model of the

20 min		hellbender life cycle, and predict vulnerabilities at different life stages.
20 min	Explain	Ecological Concepts Word Wall Teacher PowerPoint: Hellbender Ecology
15 min	Elaborate	Niche: students use knowledge of ecological concepts to predict the niche of the hellbender
15 min	Evaluate	Hellbender Quick Quiz!

LESSON STEP 1: ENGAGE
Objective: Introduce students to the hellbender salamander.
Materials:

- *The Last Dragons* video clip (and projection technology)
- Lesson 1 Student Handout

Sequence:

1. Students will watch a short video introducing the hellbender salamander and answer questions on their handout.
2. Short class discussion - teacher should review the questions that the students answered on their handout during the video.

LESSON STEP 2: EXPLORE
Objective: Students use prior knowledge to arrange the sequence of events in the hellbender life cycle, and to predict vulnerabilities at different life stages.
Materials:

- Hellbender Life Cycle Cards
- Lesson 1 Student Handout

Sequence:

1. In pairs or small groups, students work together to sort hellbender life cycle cards into the correct order.
2. Teacher should check student card sorting, and then students should illustrate the hellbender life cycle on their handout.
3. In pairs or small groups, students then brainstorm about the vulnerabilities of each stage of the life cycle - what living and non-living factors could affect the population of these salamanders at each life stage? Students should answer these questions on the handout after sketching the life cycle pictures.
4. Pairs/small groups share with other pairs/small groups their predictions for life-stage vulnerabilities and continue to add to their handout.
5. Whole class discussion: teacher solicits responses from different pairs around the classroom and facilitates a student-led discussion on life-stage vulnerabilities.

LESSON STEP 3: EXPLAIN
Objective: Students learn new vocabulary related to general ecological concepts and connect these concepts to each other through student-led discussion.
Materials:

- Ecological Concepts slips
- Posterboard or large (legal-sized) printer paper

- Markers, colored pencils, crayons, etc.
- Lesson 1 Student Handout
- Hellbender Ecology powerpoint

Sequence:

1. Teacher explains that students will be creating a Word Wall of important ecological concepts. Teacher should select a location in the classroom where Word Wall entries can be displayed.
2. Students form pairs or small groups. Teacher passes out one Ecological Concept slip to each student group.
3. Students discuss the word and definition, and then illustrate the word and definition on their larger piece of paper. The definition crafted by the students does not have to match the slip word for word, and can be constructed using the students' own words and previous knowledge. Words could include the following (but can also be adapted include others according to local standards):

Biotic/Abiotic	Niche
Population	Competition
Community	Predation
Habitat	Limiting resource
Producer	Carrying capacity
Consumer	Bioindicator

   NOTE: After students have created their Word Wall entry, the remaining sequence of this part of the lesson can be adapted for age group.

4. Option 1: Student pairs/groups can present their Word Wall entry to the class and then hang their illustration on the wall. Teacher can facilitate discussion by encouraging student groups during their short presentation to relate their term to hellbender salamanders.
5. Option 2 (Extension): Student pairs/groups can pair with another group and discuss how their two vocabulary terms relate to each other. When students present their terms to the class, the teacher can facilitate discussion by asking which group they teamed up with, and how their terms relate.
6. Option 3 (High school extension): Student groups can separate to individual students and form *new* pairs/groups to discuss how their terms relate to each other. Student-led/teacher-facilitated discussion can continue in a similar fashion as Option 2 above.

7. **Powerpoint:** After finishing the Word Wall, the teacher should show the **Hellbender Ecology** powerpoint. This powerpoint goes through each ecological concept and applies them directly to hellbenders in Appalachian streams. Students should, from the Word Wall activity, be able to help answer some questions during the slide show before the bullets are displayed on the slide. Students should fill out the blanks in their note sheet on the Lesson 1 Student Handout.

LESSON STEP 4: ELABORATE

Objective: Students synthesize knowledge from ecological concepts and video clips that they have watched to describe the niche of the eastern hellbender.

Materials:

- Lesson 1 Student Handout
- Hellbender Ecology powerpoint

Sequence:

1. Teacher displays the last slide of the powerpoint.

2. Students must write a few sentences that describe (in as much detail as possible) the niche of the eastern salamander. Students should use no fewer than 5 vocabulary words from the previous lesson step in their sentences.
3. Teacher should circulate while students are writing and can then solicit several student volunteers to read their sentences aloud to the class.

LESSON STEP 5: EVALUATE

Objective: Use a short formative assessment to measure student knowledge of ecological concepts and hellbender ecology.

Materials:

- Hellbender Quick Quiz handout

Sequence:

1. Teacher should pass out the Hellbender Quick Quiz to students (this can be adapted to use available technology, such as polleverywhere.com, Zipgrade, or other online survey software for quick grading or if remote/virtual teaching/learning is taking place).
2. Teacher should discuss answers to the quick quiz with the class, particularly as some questions have multiple possible answers.